Principles of plaster application

Introduction

The principle of management of any fracture is to reduce the fracture, immobilize until bony union is achieved and then rehabilitate the patient. There are various methods of fracture immobilization varying from simple custom-made splints or plaster application for non-operative methods to various different operative techniques.

A fracture means loss of continuity and mechanical integrity of a bone. The bone ends bleed forming a fracture haematoma and this sets up a cascade of events that stimulates callus formation which is then replaced by bone through endochondral ossification, leading to fracture union and bone remodelling. Some movement is useful in stimulating this process; however, excessive motion is detrimental to these events and will lead to fracture non-union.

Splint immobilization of fractures has been used for hundreds of years but gypsum was first used by Antonius Mathijsen in 1854. He was a Flemish military surgeon and used gypsum impregnated dressings to splint battlefield injuries.

Cast immobilization can be divided into two groups. Holding casts are used to splint undisplaced stable fractures. Moulding casts use external contours to hold the fracture reduction.

Displaced or angulated fractures require fracture reduction to obtain satisfactory bony alignment. Once reduced the fracture requires adequate support to maintain the reduced position and overcome the deforming forces on the fracture fragments.

Longitudinal traction of the involved limb will overcome the muscle spasm restoring bone length and disimpacting the fracture. This can be achieved either by simple manual traction in line of the limb or application of Chinese finger traps to the digits for disimpaction of distal radius fractures. The latter relies on gradual traction to lead to muscle fatigue and overcome the spasm.

An understanding of the mechanism of injury sustained will aid in reduction of the fracture as reversing this mechanism should allow for restoring the anatomical bony alignment. For example, a fracture of the distal radius from a fall on the outstretched hand results from supination and dorsal angulation of the distal fragments. To reduce this fracture following longitudinal traction of the forearm the wrist requires pronation and flexion to restore the anatomical alignment of the distal radius.

Frequently following fractures there is an intact periosteal soft tissue hinge. This can sometimes impede bony reduction. In this situation the soft tissue hinge needs to be relaxed by increasing the deformity before applying the longitudinal traction in order overcome this block to reduction. Once the fracture has been reduced this hinge of soft tissue aids in maintaining fracture reduction (*Figure 1*).

Plasters can be applied either as temporary splints or as definitive circumferential casts. Following an acute injury and fracture reduction it is often unwise to place the injured limb in a circumferential cast, as the limb will tend to swell. Circumferential casts may risk the development of compartment syndrome and in these cases it is often safer to apply a moulded plaster backslab which will adequately hold the fracture immobilized but still allow for swelling of the limb. The cast can then be completed or changed to a circumferential cast at a week once the initial acute swelling has subsided.

Plaster immobilization of fractures should follow a few basic principles. In order to maintain fracture reduction three-point moulding should be used (*Figure 2*). This produces tension on the side of the fracture with an intact soft tissue hinge. The initial deformity should be overcor-

Figure 1. Diagrammatic representation of intact soft tissue hinge. a. Intact soft tissue hinge preventing fracture reduction. b. Relaxation of soft tissue hinge allows bone ends to be reduced. c. Once reduced soft tissue hinge helps maintain fracture reduction.

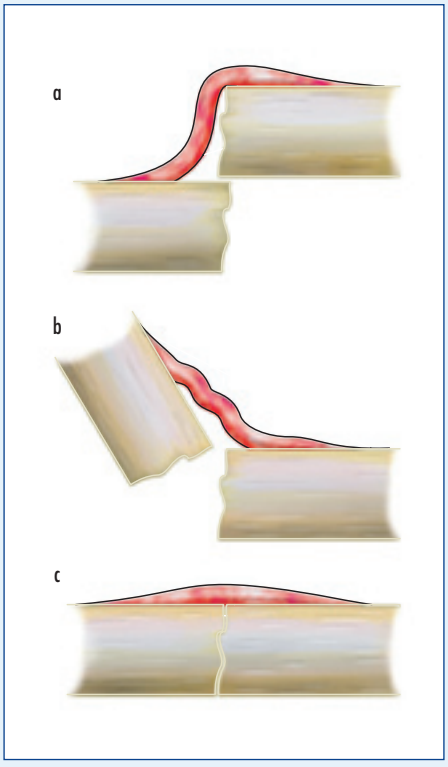

Figure 2. Principle of three-point moulding.

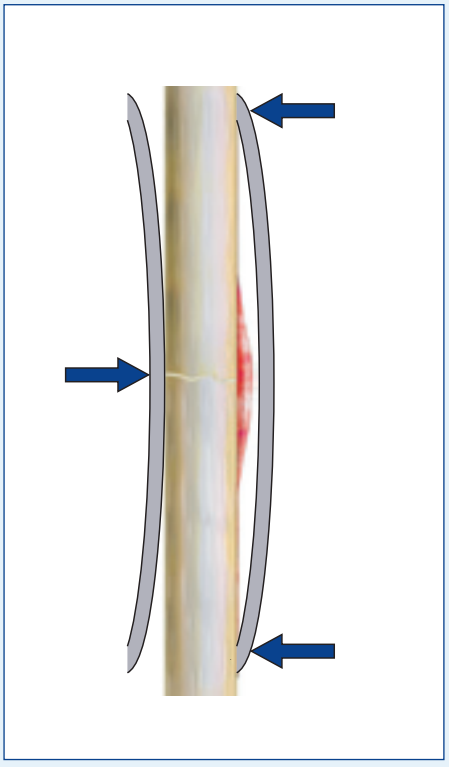

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Figure 3. Application of wadding and moulding of forearm cast.

rected. Successful moulding should result in a curved cast to immobilize a straight bone (Charnley, 1999). In fractures involving rotational deforming forces the joint above and below the fracture should be immobilized in the early phase to prevent limb rotation.

Cast application

Tubular stockinette is applied to the limb. Circumferential wadding is then applied the length of the limb to be immobilized. Too much tension should be avoided in the wadding to prevent a tourniquet affect. The wadding should be applied evenly and overlap approximately 50% of its width for each turn. Too much padding reduces the effectiveness of the cast, sufficient needs to be applied to adequately protect bony prominences (e.g. malleoli) from pressure effects.

A plaster roll of appropriate width (*Table 1*) is selected. It should be unrolled approximately 5 cm and immersed in lukewarm water, keeping hold of the roll and the end, until all the air bubbles have dispersed. The plaster should be applied to the limb in the same direction as the wadding overlapping each turn by approximately 50% the width of the roll. The aim is to achieve a plaster of even thickness throughout its length. The plaster should be smoothed using the thenar eminences, and moulded with a three-point technique

Table 1. Suggested plaster sizes for different anatomical sites

Anatomical region	Plaster width
Thigh	15 cm
Leg	10 cm
Upper limb	6 cm

Figure 4. Application of below-knee U slab.

appropriately as it sets. The ends of the plaster can be trimmed back to the appropriate length.

Lower limb backslabs require careful application as they necessitate not only a plaster slab on the posterior aspect of the limb but also a 'U' slab wound from medial to lateral over the heel to give varus/valgus and rotational stability. Following cotton wadding being wound around the limb from the metatarsal heads for the appropriate length of the leg to be immobilized the wetted U slab plaster is applied first (*Figure 4*). The wetted posterior slab is then applied (if the plaster is applied in this order then the U slab helps to hold the posterior slab while the securing bandage is wound over the top. By commencing the securing bandaging at

Figure 5. Completion of backslab by dorsiflexion of ankle and applying securing bandage from distal to proximal.

the metatarsal heads the posterior slab can be secured in place appropriately and the foot brought up to a neutral position at the ankle by gentle pressure on the sole of the foot (*Figure 5*).

Non-operative treatment of fractures with cast immobilization is labour intensive. Patients require frequent evaluation (both clinical and radiological) in the early phase of their treatment, as this is the period of greatest fracture instability while early callus is formed to help stabilize the fracture. As the swelling from the initial injury subsides the cast no longer fits snugly around the limb. This allows space for the deforming forces to displace the fracture fragments.

Clinical bony union frequently precedes radiological fracture union and treatment of a patient in a cast relies on careful regular evaluation to determine bony union. If the cast is left in-situ until radiological union is achieved then the fracture has been overtreated and the adjacent joints will have become excessively stiff, and the patient's rehabilitation delayed. BJHM

Conflict of interest: none.

Charnley J (1999) *The Closed Treatment of Common Fractures.* The Golden Jubilee Edition. Colt Books, Cambridge

KEY POINTS

- Cast immobilization can provide temporary stabilization or definitive treatment of fractures.
- Plaster immobilization of fractures relies on good three-point fixation to maintain fracture reduction.
- In general principles the joint above and below the fracture should be immobilized by the plaster.
- Definitive treatment of fractures by plaster immobilization requires careful, regular clinical and radiological assessments of the patient.